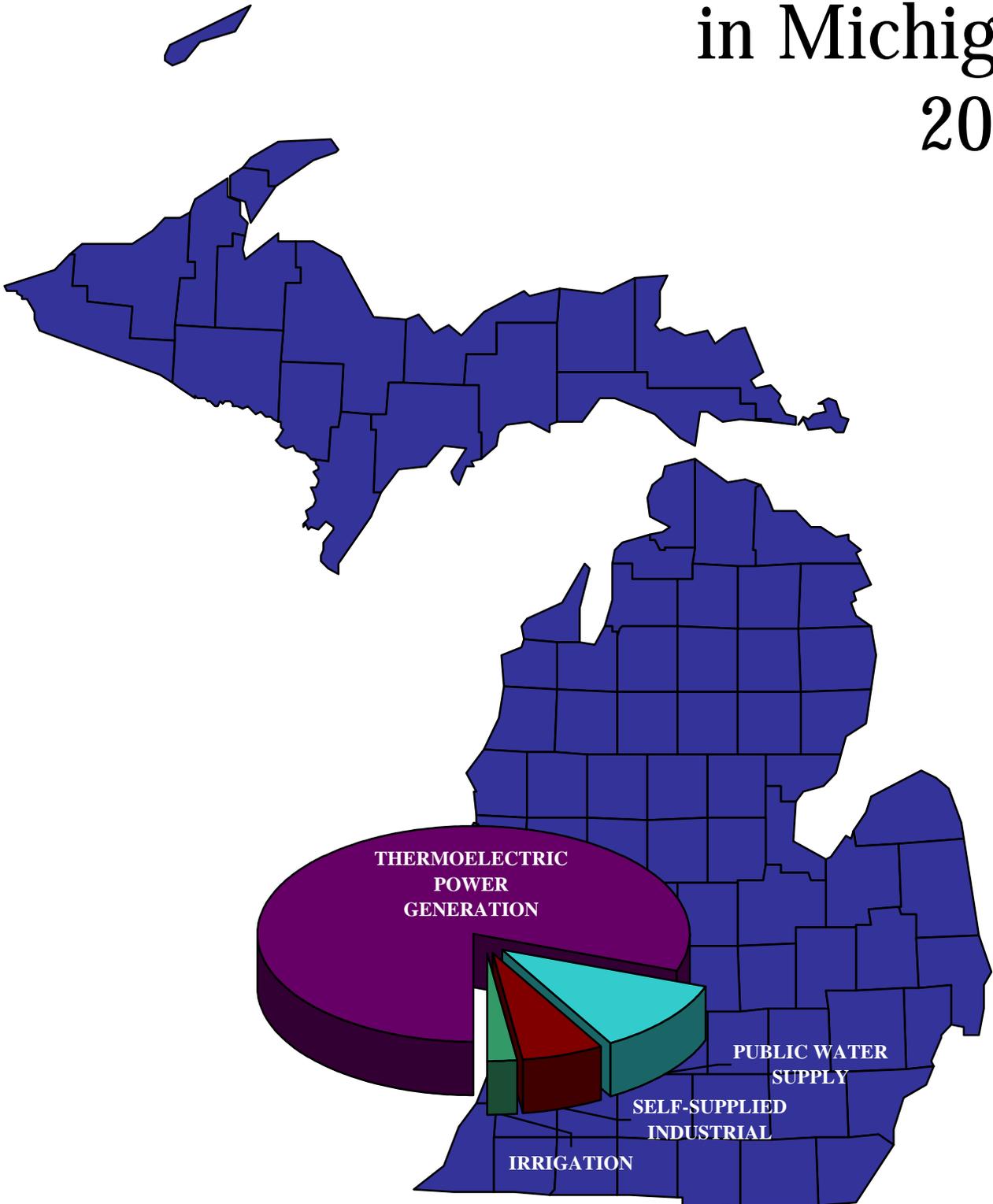


# Water Withdrawals for Major Water Uses in Michigan 2001



# Water Withdrawals for Major Water Uses in Michigan: 2001

## Introduction

The Great Lakes Basin of North America includes the largest system of fresh water lakes in the world. This world class resource supports a complex web of economic and ecological activities that are fundamental to the prosperity and quality of life in eight American states and two Canadian provinces. At the national level, the Great Lakes Basin is a significant water use region, ranking third among the twenty one major watersheds in the United States for freshwater withdrawals. While the total volume of water withdrawn by facilities within the Basin is significant, the amount consumed (e.g. effectively lost during use due to evaporation, transpiration, and incorporation into products) is estimated between five and ten percent. The rest of the water is returned to the Basin, although often through different pathways. As water moves throughout the system, distinct patterns of withdrawal, consumption, and disposition occur within the larger dynamics of the overall hydrologic cycle.

At the center of the Great Lakes Basin is Michigan, a state whose peninsular shape is defined by four of the five Great Lakes. Water resources in Michigan are considered abundant, despite a climate with generally moderate precipitation and some inland areas that experience periodic water shortages during times of drought. The mix of water-using facilities in the state is complex, with withdrawals that range from small to exceptionally large in major sectors like thermoelectric power generation, self-supplied industrial, irrigation, and public water supply. While raw water withdrawn by these facilities is generally considered a free resource rather than a commodity, there are significant economic costs and ecological impacts associated with its capture, distribution, use, and discharge. Together, these major water uses support the commerce and character of the state.

## Background

This report has been prepared by the Michigan Department of Environmental Quality to summarize information compiled in Michigan's Water Use Reporting Program. The overall goal of the program is to establish an environmental baseline and continuing assessment of major water uses, including power generation, industrial, irrigation, and public water supply. This fulfills key requirements of the Great Lakes Charter, a regional agreement signed by the states and provinces in 1985, and Michigan's water use reporting law (Part 327, Great Lakes Preservation, Natural Resources and Environmental Protection Act, 1994 PA 451, as amended). All of the states and provinces with territory within the Great Lakes Basin are mandated to compile and report similar water use information.

Detailed water use data from the states and provinces are maintained by the Great Lakes Commission to facilitate regional policy-making and strengthen the legal defense against unwarranted diversions of Great Lakes water. The regional database also provides essential water use information for water resources planning to support power generation, industrial, irrigation, and public water supply activities in a manner consistent with sound environmental management. To achieve these objectives, close cooperation is maintained with the International Joint Commission and the United States Geological Survey.

## Methodology

For the purposes of this report, data have been compiled for the major water use sectors in Michigan, including thermoelectric power generation, self-supplied industrial, irrigation, and public water supply. While there are other types of water uses that occur, it is estimated that these four categories account for over 95 percent of the total water withdrawals in the state. Collectively, they define Michigan's overall demand for water resources from the Great Lakes, inland surface sources, and ground water. Water withdrawals in the four sectors are defined as follows:

- **Thermoelectric Power Generation:** Water withdrawn for use by fossil fuel plants (using coal, oil, or natural gas) and nuclear plants. Water supplied to thermoelectric power plants by public water supply systems is not recorded in this sector.
- **Self-Supplied Industrial:** Water withdrawn for use in the manufacture of metals, chemicals, paper, and allied products. Mining water includes water used in the extraction or washing of minerals and liquids. Water supplied to industrial facilities by public water supply systems is not recorded in this sector.
- **Irrigation:** Water withdrawn and artificially applied on lands to assist in the growing of crops and pastures or in the maintenance of recreational lands such as golf courses and parks.
- **Public Water Supply:** Water withdrawn by community public water supply systems that provide year-round service to at least 15 service connections or serve an average of at least 25 residents. Community public water supply systems provide water for use by a variety of residential, public, commercial, and industrial facilities.

The water use reporting protocols established under Michigan law vary from major sector to sector. Thermoelectric power plants, self-supplied industrial facilities, and irrigated golf courses are required to report annually if they have the capacity to withdraw 100,000 gallons of water per day during any 30-day period. All community public water supply systems report water withdrawals on a monthly and/or annual basis. Agricultural irrigation withdrawals are estimated rather than reported using a computer model that utilizes weather, soils, and other resource data, including crop and acreage information reported in the Federal Census of Agriculture. Periodic estimates are also made for several smaller water use categories such as domestic and livestock water use, which are reported in the United States Geological Survey's National Water Use Information Program.

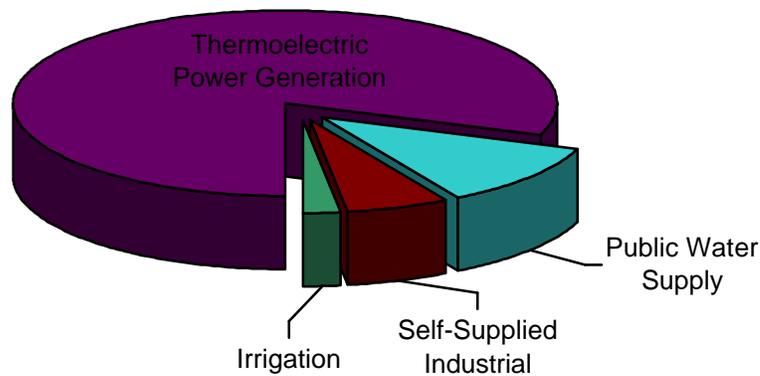
## Michigan Summary

During 2001, Michigan's thermoelectric power plants, self-supplied industries, irrigators, and public water supply systems withdrew a total of 10,633 million gallons of water per day (MGD). This represents a total water volume of nearly four trillion gallons withdrawn during the year, enough to

cover the entire state with about four inches of water. While substantial in terms of resource demand, it is estimated that over 90 percent of this water was returned to the Great Lakes, inland lakes and streams, and ground water after use. The nature of this distribution varies, however, as water is often returned to different sources after use.

The largest water withdrawals in Michigan during 2001 were made for thermoelectric power generation. Power plants accounted for nearly 81 percent of total withdrawals and collectively withdrew four times more water than community public water supply systems, self-supplied industries, and irrigators combined (See Figure 1). Public water supply systems accounted for 11 percent of the total withdrawals in the state, serving 6.9 million persons representing a mix of residential, public, commercial, and industrial facilities. Six percent of water withdrawals were made by self-supplied industries that were not connected to public water supply systems. The remaining two percent of withdrawals were made by agricultural and golf course irrigators.

**Figure 1: Water Withdrawals for Major Water Uses in Michigan: 2001**

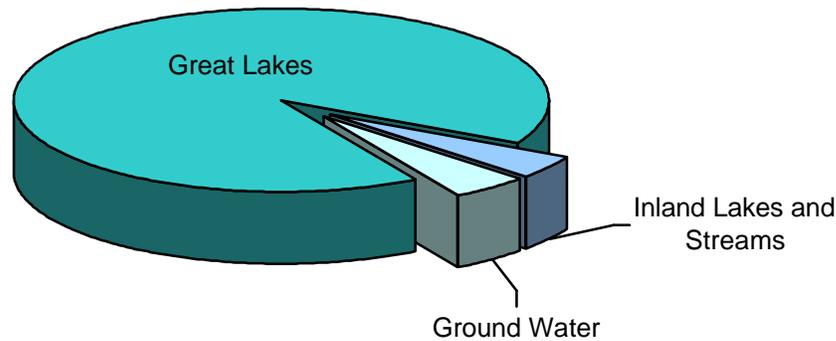


Type of Use	Number of Facilities	Water Withdrawn (MGD)
Thermoelectric Power Generation	42	8,564.94
Public Water Supply	1,474	1,191.36
Self-Supplied Industrial	410	632.98
Irrigation	2,334	243.24
Totals:	4,260	10,632.52

While there were significant differences among the major water use sectors, the primary source of water in the state was the Great Lakes and their connecting waters (See Figure 2). In fact, 91 percent

of the total water withdrawn during 2001 was from Great Lakes sources, with 4.8 percent from ground water and 4.2 percent from inland surface sources. Thermoelectric power generation was the sector with the greatest dependence on the Great Lakes (97 percent), followed by public water supply (77 percent), and self-supplied industrial use (68 percent). In contrast, irrigation water was withdrawn primarily from ground water sources (64 percent), with only 3 percent from the Great Lakes.

**Figure 2: Sources of Water for Major Water Uses in Michigan: 2001**

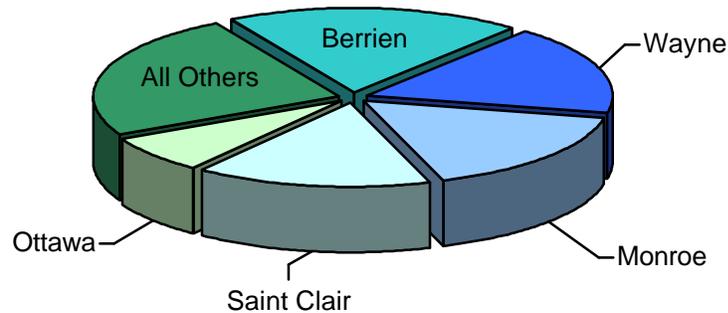


Water Source	Water Withdrawn (MGD)				Total
	TE Power Generation	Public Water Supply	Self-Supplied Industrial	Irrigation	
Great Lakes	8,319.02	917.57	431.24	7.48	9,675.31
In. Lks & Streams	242.66	19.18	102.23	79.78	443.85
Ground Water	3.26	254.61	99.51	155.98	513.36
Totals:	8,564.94	1,191.36	632.98	243.24	10,632.52

Table 1 summarizes total water withdrawals during 2001 for each of Michigan’s 83 counties. Berrien County reported the largest water withdrawals in the state, accounting for 19 percent (2,069 MGD) of the total water withdrawn for thermoelectric power generation, public water supply, self-supplied industrial use, and irrigation (See Figure 3). Michigan’s largest power generation facility, the Donald C. Cook nuclear plant, is located in Berrien County. The next largest water use counties were Wayne, Monroe, Saint Clair, and Ottawa. Together, facilities in these counties accounted for 56 percent of the water withdrawn statewide. The Great Lakes and connecting waters predominated as a source of water for the five largest water-using counties, supplying 98.8 percent of their combined water withdrawals. In each case, thermoelectric power plants withdrew the largest volumes of water, although virtually all

of it was returned to the Great Lakes after use as a cooling medium.

**Figure 3: Counties with Largest Water Withdrawals in Michigan: 2001**



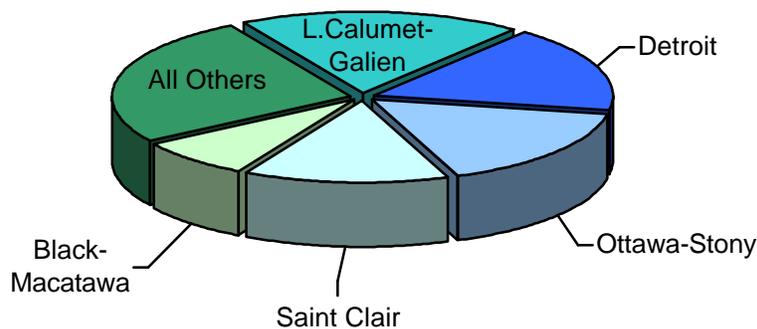
Name of County	Water Withdrawn (MGD)				Total
	TE Power Generation	Public Water Supply	Self-Supplied Industrial	Irrigation	
Berrien	2,042.54	17.42	2.79	6.04	2,068.79
Wayne	973.75	523.70	319.77	2.44	1,819.66
Monroe	1,711.70	12.59	16.00	3.79	1,744.08
Saint Clair	1,464.72	171.97	12.22	0.58	1,649.49
Ottawa	712.57	41.70	11.77	9.07	775.11
All Others	1,659.66	423.98	270.43	221.32	2,575.39
Totals:	8,564.94	1,191.36	632.98	243.24	10,632.52

Table 2 summarizes total water withdrawals by United States Geological Survey hydrologic basins in Michigan. The largest withdrawals were reported in the Little Calumet-Galien Watershed (Basin 04040001), accounting for 19 percent of the water withdrawn for thermoelectric power generation, public water supply, self-supplied industrial use, and irrigation (See Figure 4). Water withdrawals by the next four watersheds accounted for an additional 55 percent of total withdrawals statewide. They were the Detroit Watershed (Basin 04090004), the Ottawa-Stony Watershed (Basin 04100001), the Saint Clair Watershed (Basin 04090001), and the Black-Macatawa Watershed (Basin 04050002). As with counties, facilities within the five largest water-withdrawal watersheds relied almost exclusively (99.6 percent) on the Great Lakes and their connecting waters as their source.

While water withdrawal data are reported with reasonable accuracy in Michigan, consumptive water

use values are significantly more difficult to determine. It is generally agreed that overall consumptive water use in the state falls between 5 to 10 percent of total withdrawals, which would indicate a range of 532 MGD to 1,063 MGD during 2001. However, the process of estimating consumptive water use is complicated by several factors. Overall, consumptive use varies from sector to sector, with the lowest rate for thermoelectric power generation and the highest rate for irrigation. Within a given sector consumptive use rates can also vary widely from facility to facility. This is particularly evident for self-supplied industries, where manufacturing and water use processes are diverse in nature.

**Figure 4: Hydrologic Basins with Largest Water Withdrawals in Michigan: 2001**



Name of Basin	Water Withdrawn (MGD)				Total
	TE Power Generation	Public Water Supply	Self-Supplied Industrial	Irrigation	
L. Calumet-Galien (04040001)	2,042.54	3.02	1.15	0.13	2,046.84
Detroit (04090004)	973.75	517.43	309.66	2.52	1,803.36
Ottawa-Stony (04100001)	1,711.70	3.14	6.89	3.22	1,724.95
Saint Clair (04090001)	1,464.72	15.19	12.29	3.01	1,495.21
Black-Macatawa (04050002)	743.27	45.20	9.90	7.74	806.11
All Others	1,628.96	607.38	293.09	226.62	2,756.05
Totals:	8,564.94	1,191.36	632.98	243.24	10,632.52

As more data are compiled in Michigan’s Water Use Reporting Program, estimates of consumptive water use will improve. Longer-term trend analysis will also be undertaken for each water use sector to determine water supply and demand relationships over time. This information will support the continued development of safe, reliable public and private water supplies in Michigan and provide a continuing environmental baseline to ensure the protection and wise management of the waters of the Great Lakes Basin.

**Table 1: 2001 Water Withdrawals for Major Water Uses in Michigan, by County\***

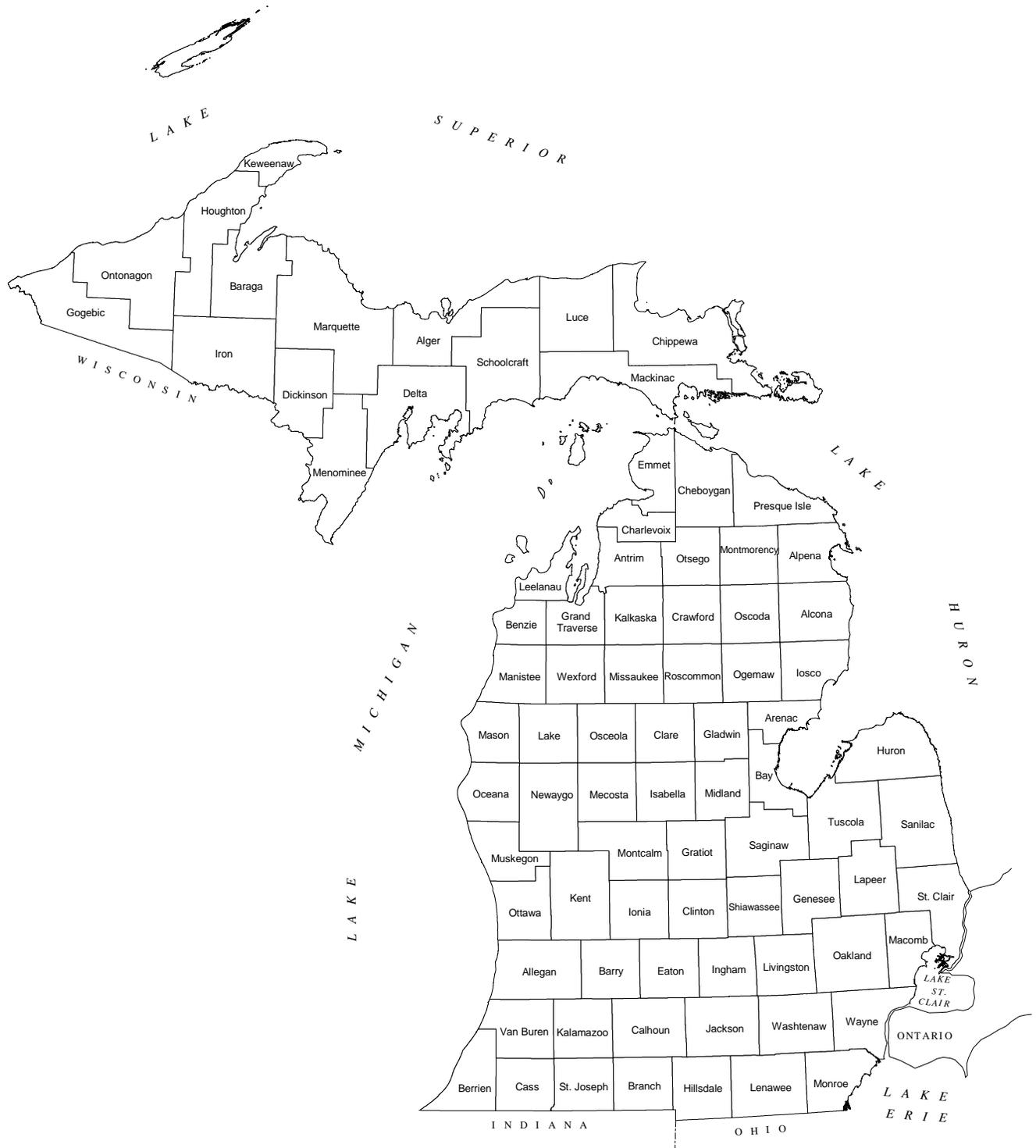
County	Number of Facilities	Water Withdrawn (MGD)			Total
		Great Lakes	Surface Water	Ground Water	
Alcona	11	0.00	0.06	0.65	0.71
Alger	9	5.50	0.00	0.91	6.41
Allegan	160	0.00	5.44	9.76	15.20
Alpena	14	119.45	0.10	1.00	120.55
Antrim	33	0.00	0.13	3.83	3.96
Arenac	22	38.19	0.14	0.66	38.99
Baraga	7	3.24	0.02	0.06	3.32
Barry	41	0.00	0.47	2.40	2.87
Bay	69	633.84	4.52	0.37	638.73
Benzie	25	0.00	0.02	1.74	1.76
Berrien	174	2,055.28	3.88	9.63	2,068.79
Branch	120	0.00	5.69	11.20	16.89
Calhoun	86	0.00	5.18	25.09	30.27
Cass	85	0.00	1.61	9.22	10.83
Charlevoix	32	40.77	0.21	14.21	55.19
Cheboygan	14	0.00	0.38	2.16	2.54
Chippewa	11	2.79	0.00	1.09	3.88
Clare	9	0.00	0.14	1.38	1.52
Clinton	42	0.00	0.55	3.18	3.73
Crawford	13	0.00	0.08	1.63	1.71
Delta	25	22.58	0.88	0.68	24.14
Dickinson	17	0.00	17.98	3.40	21.38
Eaton	32	0.00	1.54	4.01	5.55
Emmet	46	0.00	0.00	4.82	4.82
Genesee	90	0.00	1.80	8.77	10.57
Gladwin	11	0.00	0.00	0.52	0.52
Gogebic	12	0.00	0.00	2.22	2.22
Grand Traverse	74	5.34	0.27	4.61	10.22
Gratiot	34	0.00	1.28	3.26	4.54
Hillsdale	40	0.00	1.47	5.18	6.65
Houghton	21	0.00	0.03	3.67	3.70
Huron	48	54.21	0.28	2.14	56.63
Ingham	55	0.00	206.34	38.65	244.99

County	Number of Facilities	Water Withdrawn (MGD)			
		Great Lakes	Surface Water	Ground Water	Total
Ionia	42	0.00	0.50	6.45	6.95
Iosco	21	1.24	0.35	0.65	2.24
Iron	23	0.00	0.43	2.41	2.84
Isabella	31	0.00	0.33	3.98	4.31
Jackson	82	0.00	1.04	14.97	16.01
Kalamazoo	121	0.00	8.94	64.83	73.77
Kalkaska	10	0.00	0.38	3.10	3.48
Kent	158	50.81	2.62	11.86	65.29
Keweenaw	6	0.01	0.00	0.06	0.07
Lake	6	0.00	0.00	0.30	0.30
Lapeer	40	0.00	1.26	0.92	2.18
Leelanau	62	0.01	0.17	2.87	3.05
Lenawee	64	0.00	4.18	4.05	8.23
Livingston	86	0.00	0.41	8.42	8.83
Luce	8	0.00	0.03	0.80	0.83
Mackinac	10	8.34	0.02	0.15	8.51
Macomb	65	4.20	2.51	2.01	8.72
Manistee	45	18.65	19.08	4.20	41.93
Marquette	33	269.81	14.62	2.87	287.30
Mason	39	18.19	0.56	1.94	20.69
Mecosta	32	0.00	0.54	4.99	5.53
Menominee	11	1.15	2.87	0.24	4.26
Midland	15	0.07	4.04	0.32	4.43
Missaukee	21	0.00	0.18	2.25	2.43
Monroe	45	1,723.26	5.00	15.82	1,744.08
Montcalm	103	0.00	4.99	29.70	34.69
Montmorency	6	0.00	0.21	0.28	0.49
Muskegon	80	309.09	5.99	8.55	323.63
Newaygo	39	0.00	0.72	2.79	3.51
Oakland	201	0.00	1.87	28.87	30.74
Oceana	40	0.00	0.72	3.09	3.81
Ogemaw	13	0.00	0.12	0.62	0.74
Ontonagon	9	14.45	0.00	0.10	14.55
Osceola	23	0.00	0.21	3.91	4.12
Oscoda	9	0.00	0.16	0.35	0.51

County	Number of Facilities	Water Withdrawn (MGD)			Total
		Great Lakes	Surface Water	Ground Water	
Otsego	29	0.00	0.08	2.44	2.52
Ottawa	187	726.33	41.07	7.71	775.11
Presque Isle	26	5.10	1.45	3.07	9.62
Roscommon	24	0.00	0.10	0.66	0.76
Saginaw	54	11.93	2.73	1.98	16.64
Saint Clair	104	1,648.03	0.25	1.21	1,649.49
Saint Joseph	235	0.00	14.37	36.15	50.52
Sanilac	42	0.18	0.45	4.54	5.17
Schoolcraft	6	5.46	6.16	0.02	11.64
Shiawassee	36	0.00	0.63	3.48	4.11
Tuscola	46	3.31	0.18	4.41	7.90
Van Buren	143	68.62	1.11	8.73	78.46
Washtenaw	87	0.00	16.92	11.02	27.94
Wayne	138	1,805.88	12.69	1.09	1,819.66
Wexford	22	0.00	0.12	6.03	6.15
<b>Total</b>	<b>4,260</b>	<b>9,675.31</b>	<b>443.85</b>	<b>513.36</b>	<b>10,632.52</b>

\* This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program for thermoelectric power generation, public water supply, self-supplied industrial, and irrigation.

# Index Map of Michigan Counties



**Table 2: 2001 Water Withdrawals for Major Water Uses in Michigan, by Hydrologic Basin\***

Hydrologic Basin Code	Number of Facilities	Water Withdrawn ((MGD))			Total
		Great Lakes	Surface Water	Ground Water	
04010302	3	0.00	0.00	1.41	1.41
04020101	10	6.45	0.00	0.76	7.21
04020102	7	8.00	0.00	0.14	8.14
04020103	28	0.01	0.03	3.74	3.78
04020104	2	0.00	0.03	0.02	0.05
04020105	23	273.04	0.04	1.62	274.70
04020201	11	5.50	0.03	0.87	6.40
04020202	7	0.00	0.03	0.70	0.73
04020203	2	0.00	0.00	0.09	0.09
04030106	19	0.00	0.00	2.33	2.33
04030107	5	0.00	0.43	0.25	0.68
04030108	23	0.00	20.84	3.54	24.38
04030109	7	1.15	0.04	0.09	1.28
04030110	14	0.00	15.03	1.15	16.18
04030111	18	22.58	0.37	0.65	23.60
04030112	2	0.00	0.00	0.06	0.06
04040001	19	2,045.36	1.19	0.29	2,046.84
04050001	786	7.96	28.91	89.88	126.75
04050002	185	796.79	3.12	6.20	806.11
04050003	296	0.00	16.74	88.78	105.52
04050004	160	0.00	208.38	56.04	264.42
04050005	67	0.00	1.06	6.04	7.10
04050006	315	51.14	45.53	41.50	138.17
04050007	70	0.00	1.21	5.06	6.27
04060101	137	28.22	1.37	9.34	38.93
04060102	171	298.81	8.46	26.09	333.36
04060103	57	18.65	19.37	8.85	46.87
04060104	80	0.00	0.29	4.68	4.97
04060105	199	46.13	0.48	29.56	76.17
04060106	8	0.00	6.19	0.08	6.27
04060107	3	5.46	0.00	0.09	5.55
04070001	10	2.79	0.03	0.99	3.81
04070002	5	8.33	0.00	0.03	8.36

Hydrologic Basin Code	Number of Facilities	Water Withdrawn ((MGD))			
		Great Lakes	Surface Water	Ground Water	Total
04070003	30	8.02	1.18	2.39	11.59
04070004	32	0.00	0.33	2.47	2.80
04070005	4	0.00	0.05	0.67	0.72
04070006	24	116.52	0.65	2.00	119.17
04070007	49	0.00	0.66	3.79	4.45
04080101	45	39.44	0.36	1.32	41.12
04080102	19	0.23	0.72	0.37	1.32
04080103	81	4.29	2.26	3.83	10.38
04080104	78	210.23	0.10	0.66	210.99
04080201	39	0.07	4.07	2.04	6.18
04080202	56	0.00	1.68	7.35	9.03
04080203	109	0.00	1.18	11.41	12.59
04080204	109	0.00	2.53	7.77	10.30
04080205	44	0.47	0.59	4.52	5.58
04080206	55	645.20	3.62	0.64	649.46
04090001	75	1,489.28	1.35	4.58	1,495.21
04090002	17	6.33	0.19	0.12	6.64
04090003	145	6.87	3.33	21.13	31.33
04090004	165	1,798.07	3.19	2.10	1,803.36
04090005	188	0.64	26.76	18.44	45.84
04100001	37	1,714.69	2.53	7.73	1,724.95
04100002	91	8.59	7.15	16.16	31.90
04100003	7	0.00	0.03	0.10	0.13
04100006	12	0.00	0.14	0.85	0.99
Total	4,260	9,675.31	443.85	513.36	10,632.52

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# Index Map of Michigan Hydrologic Basins

